

# **The Helfrich Free Energy for a Spherical Interface**

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We derive an effective interface model for a spherical interface generated for a fluid model described by a local free energy density functional that contains square- gradient and square -Laplacian terms. The model is equivalent to a Helfrich free energy that identifies the curvature and rigidity terms with displacements of the interface, in contrast to previous theories that evaluate the properties of the interface only at the extrema of the free-energy. These displacements correspond to the equilibrium profiles of the same density functional but now in the presence of an external potential that pins a reference value of the density to the position of the interface. The Laplace equation is recovered and its solutions coincide with those of the associated Euler-Lagrange equation. We find that the position of the interface is dependent on the choice of the reference density, and that a formalization of the Gibbs dividing surface leads to curvature contributions that vanish when the coefficient of the square Laplacian term is constant. The notional dependence of the interfacial coefficients on the position of the Gibbs surface of common use in previous theories is also clarified. Using this model we investigate the nucleation in simple systems and the formation of micelles in ternary systems.